JACC Vol. 21, No. 3
March 1, 1993:567–70

Safety, Feasibility and Cost of Outpatient Radiofrequency Catheter Ablation of Accessory Atrioventricular Connections

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Objectives. The purpose of this study was to evaluate prospectively the safety, feasibility and cost of performing radiofrequency catheter ablation of accessory atrioventricular (AV) connections on an outpatient basis in 137 cases.

Background. The efficacy and low complication rate of radiofrequency ablation as performed in the hospital suggested that it might be feasible to perform it on an outpatient basis.

Methods. In 100 cases (73%) performed between September 1, 1991 and April 20, 1992, patients met criteria for treatment as outpatients. Reasons for exclusion were age <13 or >70 years (4), anteroseptal location of the accessory AV connection (5 patients), obesity (>30% of ideal body weight) (4 patients) or clinical indication for hospitalization (24 patients). Patients with only venous punctures had a recovery period of 3 h and those with arterial punctures had a recovery period of 6 h. There were 63 men and 32 women (5 patients underwent two ablation procedures >1 month apart), with a mean age ± SD of 36 ± 13 years. The pathway was left-sided in 67 cases and right-sided or posteroseptal in 33.

Results. The procedure was successful in 97 of 100 cases, with a mean procedure duration of 99 ± 42 min. In 70 cases the patient was discharged the day of ablation, and in 30 cases the patient required a short (≤18-h) overnight stay because the procedure was completed too late in the day for recovery in the outpatient facility. The mean duration of observation was 4.8 ± 1.5 h for outpatients and 15 ± 1.4 h for patients who underwent overnight hospitalization. At follow-up study, two patients had a clinically significant complication; both had a femoral artery pseudoaneurysm detected ≥1 week after the procedure and both required surgical repair. Thirty consecutive patients (22 outpatients and 8 hospitalized overnight) undergoing catheter ablation after January 1, 1992 were chosen for a cost analysis. The mean cost of the procedure was $10,183 ± $1,082.

Conclusions. The majority of patients undergoing radiofrequency catheter ablation of an accessory AV connection can be treated safely on an outpatient basis.

(J Am Coll Cardiol 1993;21:567–70)

Radiofrequency catheter ablation of accessory atrioventricular (AV) connections has an efficacy of ≈95% and a favorable cost profile when compared with other forms of therapy (1–5). Standard clinical practice has been to keep patients in the hospital for 2 to 5 days after the procedure (1–4). However, most reported complications have been apparent either during or immediately after the ablation procedure, and no life-threatening complications have been noted during the postprocedure hospital phase in any report (1,3,4). These findings suggest that it might be feasible to perform this procedure on an outpatient basis.

The purpose of this prospective study was to evaluate the feasibility, safety and cost of performing radiofrequency catheter ablation on an outpatient basis or with a limited overnight hospital stay in low risk patients.

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Manuscript received June 5, 1992; revised manuscript received August 3, 1992, accepted August 4, 1992.

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Methods

Study design and patient selection. Ninety-five of 132 patients who underwent radiofrequency catheter ablation of an accessory AV connection between September 1, 1991 and April 20, 1992 were enrolled in this prospective study. Patients undergoing radiofrequency ablation of accessory AV connections during the time period of this study were excluded from enrollment if they were already inpatients (8 patients), <13 years old or >70 years old (4 patients), morbidly obese (>30% of ideal body weight) (4 patients), had an anteroseptal accessory AV connection (5 patients), had a complication recognized during the ablation session (2 patients), required a transseptal approach (1 patient) or required observation or treatment for other medical conditions (13 patients).

The 95 patients in this study underwent 100 separate radiofrequency ablation procedures that formed the basis of this study. Ninety patients underwent a single ablation procedure, and five patients underwent two ablation procedures at least 1 month apart during the study period. Informed consent was obtained under an investigational protocol approved by the Human Research Committee at the University of Michigan Hospitals.

0735-1097/93/$6.00

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Electrophysiologic testing and ablation protocol. Electrophysiologic tests were performed with patients in the fasting state at least 24 h after discontinuation of all antiarrhythmic medications. All patients initially had three 7F or 8F sheaths placed in the right femoral vein and three quadripolar electrode catheters positioned in the high right atrium, His bundle position and right ventricle. No patient had brachial, internal jugular or subclavian lines placed. An initial diagnostic study was performed to determine the anterograde and retrograde block cycle lengths and effective refractory periods of the accessory AV connections and AV node, tachycardia mechanisms and general location of the accessory pathway (right- versus left-sided). If coronary sinus recordings were required, they were obtained by placing a steerable catheter in the coronary sinus from the femoral vein. Patients with left-sided accessory pathways had an additional 8F sheath placed in the right femoral artery. After preliminary localization of the accessory AV connection, precise mapping was performed by using bipolar recordings from the distal pole of a 7F quadripolar electrode catheter with a 4-mm distal electrode and a deflectable curve (1,2). Right-sided accessory AV connections were localized and ablated with use of a catheter introduced into the heart through the right femoral vein and positioned in the atrial side of the tricuspid anulus; left-sided connections were localized and ablated by using a catheter introduced into a right femoral artery advanced retrogradely across the aortic valve and positioned on the ventricular side of the mitral anulus. All patients undergoing ablation of right-sided accessory AV connections were given an intravenous 3,000-IU bolus of heparin after initial catheter placement. Patients undergoing ablation of left-sided accessory AV connections were given a 5,000-IU bolus of heparin before placement of the catheter in the left ventricle, and then 1,000 IU/h thereafter.

Catheter ablation was performed by using radiofrequency energy delivered as a continuous, unmodulated sine wave at 500 kHz between the distal electrode and a large skin electrode positioned on the patient's upper back. Radiofrequency energy was applied at power outputs of 20 to 50 W for 5 to 30 s as needed to achieve successful ablation.

Postprocedure recovery and follow-up. Atrial and ventricular pacing were performed 15 to 30 min after successful ablation to confirm the absence of accessory pathway conduction. Catheters and sheaths were removed on completion of the procedure, and manual compression was maintained until complete hemostasis was achieved. After the procedure, patients were observed for 3 h if only venous access had been used and for 6 h if an arterial sheath had been placed. All patients had a two-dimensional echocardiogram performed before leaving the electrophysiology laboratory. Patients were sent to an outpatient recovery unit if the postprocedure observation could be completed by 7 PM; otherwise, they were admitted to the hospital for an overnight stay and discharged the next morning. Patients were scheduled for a follow-up evaluation at our institution or with the referring physician 1 to 3 weeks after the procedure.

Cost analysis. A subset of 30 consecutive patients included in this study who underwent radiofrequency catheter ablation between January 1, 1992 and March 1, 1992 were selected for cost analysis. Charges were obtained by a review of the patients' billing records. The total cost of the procedure was calculated by combining physicians' fees and hospital charges. Physicians' fees included all charges incurred for performance and interpretation of electrophysiologic study and catheter ablation procedure. Hospital charges included all charges for room and board and charges for the electrophysiology laboratory, recovery room and laboratory work. All charges are expressed in 1992 dollar values.

Statistical analysis. All results are expressed as mean value ± SD. Cost comparisons were performed by using the Student unpaired *t* test.

Results

Patient characteristics and results of ablation. There were 63 men and 32 women with a mean age (±SD) of 36 ± 13 years. Eighty-nine patients had no apparent structural heart disease, one had Ebstein's anomaly, one had congenital pulmonary valve stenosis, two had mitral valve prolapse, one had coronary artery disease and one had mild aortic valve insufficiency. The accessory AV connection was right-sided or posteroseptal in 33 cases and left-sided in 67; it was overt in 70 cases and concealed in 30. Accessory pathway conduction was no longer present by the end of the ablation procedure in 97 of 100 cases. The mean time required for insertion of sheaths and catheters, the diagnostic portion of the procedure and catheter ablation was 99 ± 42 min.

Immediate postprocedure recovery. In 70 cases, patients were treated on an outpatient basis, and in 30 cases they were admitted to the hospital for an overnight stay (≤18 h) and discharged the next morning. The mean time for observation was 4.8 ± 1.5 h for outpatients and 15 ± 1.4 h for those admitted overnight. In no patient did the postprocedure two-dimensional echocardiogram show an abnormality attributable to the ablation procedure. Four patients had abnormal postprocedure echocardiograms (one had Ebstein's anomaly and an atrial septal defect, one had a bicuspid aortic valve, one had right ventricular hypertrophy secondary to congenital pulmonary valve stenosis and one had mitral valve prolapse). The physical examination performed before discharge demonstrated a small hematoma at the puncture site in five patients. No new heart murmurs were present.

Short-term follow-up. The patients were examined a mean of 17 ± 7 days after the procedure. Nine patients had the recurrence of accessory pathway conduction detected by either the reemergence of pre-excitation on the electrocardiogram (ECG) (five patients) or symptoms of paroxysmal supraventricular tachycardia during the follow-up period

Table 1. Cost of Radiofrequency Catheter Ablation in 30 Patients

	Outpatients (n = 22)	Patients With Overnight Stay (n = 8)	p Value
Total charges	$9,873 ± $932	$11,034 ± $1,056	< 0.01
Professional fees	$6,163 ± $590	$ 6,286 ± $576	NS
Hospital charges	$3,710 ± $650	$ 4,748 ± $741	< 0.01

(four patients). No patients had a life-threatening complication after hospital discharge. Two patients had clinically significant complications after discharge. Both developed a femoral artery pseudoaneurysm that required surgical repair: the aneurysm was noted 1 week after the procedure in one patient and at 3 weeks in the other. One of these patients had been treated as an outpatient, and the other had been discharged after a 13-h overnight hospital stay. Neither patient had abnormal findings on examination before hospital discharge.

Cost data. The 30 consecutive patients in whom cost analyses were performed included 22 outpatients and 8 patients admitted to the hospital overnight. The mean total charges for the 30 patients analyzed was $10,183 ± $1,082 (Table 1). There was no difference between the outpatients and patients admitted overnight for observation with respect to professional fees, but the total charges and hospital charges were significantly less in the outpatient group ($p < 0.01$).

Discussion

The main finding of this study is that it is feasible and safe to perform radiofrequency catheter ablation of accessory AV connections in low risk patients on an outpatient basis or with an overnight hospital stay. During the period of patient enrollment for this study, approximately 75% of patients referred for catheter ablation of an accessory AV connection met the criteria for selecting patients in whom outpatient treatment would be safe. The low incidence of complications in these patients demonstrates that the majority of patients undergoing catheter ablation of an accessory AV connection can be safely treated on an outpatient basis.

Comparison with previous studies. Previous studies of outpatient invasive cardiac procedures have demonstrated that in properly selected patients, cardiac catheterizations and electrophysiologic tests can be performed safely and with significant cost advantage over inpatient procedures. Kadish et al. (6) analyzed 100 consecutive outpatient electrophysiologic procedures and found no complications and an average cost savings (expressed in 1988 dollar values) of ≈$3,500/patient for outpatient compared with inpatient procedures.

Diagnostic electrophysiologic tests generally do not require arterial cannulation except for hemodynamic monitoring; therefore, the vascular complication rate would be expected to be low. In the present study, radiofrequency catheter ablation of left-sided accessory AV connections was performed by using femoral artery cannulation with an 8F sheath; therefore, the vascular complication rate might be expected to be similar to that of cardiac catheterization procedures that use similarly sized arterial sheaths. In their prospective randomized study of outpatient versus inpatient cardiac catheterizations, Block et al. (7) performed arterial cannulations with 7F or 8F catheters; major vascular complications occurred in 1.6% of outpatients and 1.1% of inpatients (p = NS). Similarly, the three largest studies (2–4) of inpatients who underwent radiofrequency catheter ablation of accessory AV connections reported a significant vascular complication in 7 (1.4%) of the 508 patients.

The only complications in our study occurred in two patients who developed a femoral artery pseudoaneurysm requiring surgical repair. This complication rate of 2% is similar to the complication rate in patients undergoing radiofrequency catheter ablation on an inpatient basis.

No published studies have reported any arrhythmic complications after radiofrequency ablation, and preliminary studies of programmed stimulation after radiofrequency ablation have shown no evidence of proarrhythmic effects (8). None of the patients in this study experienced syncope or death after the ablation procedure, thus supporting the idea that prolonged ECG monitoring is not necessary after radiofrequency ablation of accessory AV connections. In contrast, when direct current energy is used for ablation of accessory AV connections, sudden death has been reported within 1 week after ablation (9).

Another possible concern in treating patients as outpatients after radiofrequency ablation is occult cardiac perforation that could result in cardiac tamponade. In the present study this possibility was investigated by obtaining echocardiograms before the patients left the electrophysiology laboratory. In no patient did the postprocedure echocardiogram demonstrate a pericardial effusion and no patient developed cardiac tamponade.

Because an internal jugular or subclavian vein puncture was not attempted in any patient in this study, chest X-ray films were not obtained after the ablation procedure. However, if central venous access is attempted, it may be advisable for patients to undergo a chest X-ray study to rule out a pneumothorax before discharge.

Reasons for exclusion. In this study, patients who were not appropriate candidates for outpatient management were excluded. Because of the risk of complete heart block (2,3), patients who had an anteroseptal accessory AV connection were admitted to a monitored unit after the ablation procedure. Severely obese patients were excluded because of concern of an increased risk of bleeding at the sites of femoral artery or vein punctures. Other patients were excluded because they had been transferred from another hospital and were already inpatients. These patients often had been admitted to the outside hospital because of severe symptoms, such as cardiac arrest or syncope. Because of the severity of the presenting symptoms, they were treated on

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an inpatient basis and often underwent a predischarge electrophysiologic test to confirm a successful outcome. Patients with other medical conditions that required inpatient hospitalization were also excluded from the study. Overall, ≈25% of patients referred for ablation of an accessory AV connection were considered inappropriate candidates for outpatient management. However, the majority of patients referred for catheter ablation were appropriate candidates for outpatient management.

Cost analysis. Previous studies have demonstrated that radiofrequency catheter ablation offers a significant cost advantage over medical therapy in patients with medically refractory paroxysmal supraventricular tachycardia and that radiofrequency catheter ablation of accessory AV connections is significantly less expensive than surgical ablation (5,10). In the study by de Buitleir et al. (5) the total cost for definitive therapy of accessory AV connections was linearly related to the length of hospital stay for both catheter and surgical ablations, indicating the importance of the length of hospital stay in determining the cost of patient care. In that study the mean total charges for radiofrequency catheter ablation were $14,919 ± $6,740 (expressed in 1990 to 1991 dollar values) and the mean hospital stay was 3.1 ± 1.3 days. The results of the present study demonstrate that the total charges for radiofrequency ablation of an accessory AV connection can be reduced by approximately 33% when the procedure is performed on an outpatient basis or with only an overnight stay.

Conclusions. This study shows that a majority of patients undergoing radiofrequency catheter ablation of accessory AV connections are candidates for outpatient management. In properly selected patients, outpatient management is both safe and feasible and results in significant cost savings.

We are grateful to Marion Maguire for assistance in the preparation of this manuscript.

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